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An Application of Holistic Feasibility Study to Determine Valuable Chain in Palm Oil Industry: A Case Study

W. Sutopo[1], D. I. Maryanie[2], Yuniaristanto[3], M. Hisjam[4]

[1] Industrial Engineering and Techno Economy Research Group, Industrial Engineering Department
Sebelas Maret University, Surakarta, 57126, INDONESIA
wahyudisutopo@gmail.com
[2,3,4] Industrial Engineering Department
Sebelas Maret University, Surakarta, 57126, INDONESIA

[2]dwiindahmaryanie@yahoo.com; [3]yuniaristanto@gmail.com; [4]mhisjam@yahoo.com

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Abstract

Palm has a good market prospect in the future. Almost all parts of this commodity have their benefits, ranging from the leaves to the roots and from upstream to downstream. However, it would be a big problem to determine the most viable commodity to be developed for hundreds of alternatives derivative palm oil products. This paper aims to present an application to help in deciding between multiple options of derivative products of palm oil. The application is built in Visual Basic Macro within Microsoft Excel (Macro Excel) by using the decision matrix method. It will allow to establish the concept of weighting the criteria in order of importance by scoring them against different criteria. The most important criteria, the higher weighting it will be given. So that the proposed application can be implemented to evaluate which are the most valuable coin from all levels of derivative products in the Palm Oil supply chain.

Keyword: Decision Matrix Method, Macro Excel, Palm Oil Industry, Supply Chain, Valuable Chain

1. INTRODUCTION

The palm is the most productive and economical agricultural compared to the others (Ministry of Industry of Republic of Indonesia, 2011). Almost all parts of the tree have their benefits, ranging from roots, leaves, flowers, flower stalks, stems, up to the fresh fruit bunches (FFB). But the main part of this commodity is in its fruit, or usually called by FFB. The FFB is the main producers for two kinds of palm oil, named Crude Palm Oil (CPO) and Palm Kernel Oil (PKO) (Satyawibawa & Widayastuti, 2000). Both of these oil have a bright future since their global demand is still growing by five percent every year (Coordinating Ministry for Economic Affairs, 2011) and also the ability of production is far below the world consumption, so that it makes the prices will continue to rise (Commission for the Supervision of Business Competition, 2006).

As the world's top producer and exporter of palm oil, this commodity certainly plays a very important role in the Indonesian economy (Crutchfield, 2007). However, until at the end of 2010 most of the parts of this commodity are allocated to produce CPO only (Yulisman, 2011), so no wonder Indonesia could surpass Malaysia became the highest producer of CPO in the world, which was used to be the largest one (MPOB Malaysia, 2008; Mayun, 2009; Scientific American Board of Editors, 2012; Pakiam, 2013).

Indonesia should develop the other derivative products from other parts of this commodity, besides on producing of CPO. It is required to maintain Indonesia's position as the largest palm producer, which is not only limited to its upstream but also to downstream of Palm Oil supply chain. It consists of supplier CPO, palm oil mill, fractionation and distillation CPO industry, and purification or derivative industry (Maryanie et.al., 2013). However, the process for developing derivative industry is not easy, it takes much time and cost to make it happen. Therefore, it needs to be determined the most valuable for palm oil derivative products by considering the whole of the chain of industrial tree so that in making its determination not only focuses on the derivative of one part, but also considers all parts of the palm tree. Moreover, not only focuses on one industry level, but also to examine all industry levels like upstream, intermediate and downstream level of in the Palm Oil supply chain.

Many researchers have been interested to study about palm oil. Hambali (2005) has discussed about the development of palm oil industry clusters. Numerous studies in analyzing scenarios about the palm oil supply chain: Van Duijn (2013); Alfonso et.al (2009); Utama et. al. (2011); Golpavar & Seifbarghy (2009). Then supply chain by considering three aspects such as economical revenue, social welfare, and environment for crude palm oil only, not involving its derivative products had been discussed (Widodo et.al., 2010). References to McCarthy et.al. (2012) and Pahan et.al (2011) analyzes feasibility of local production network in Indonesia compared to global production. Models for improving supply chain to enhance the coordination of the key business processes from suppliers to consumers had been proposed too by providing value added services in agri-food supply chain (Sutopo et.al., 2012; Sutopo et.al., 2013; Cruz, 2008).

This paper aims to extend previous research from Maryanie et.al. (2013) that introduced a framework for determining the most potential commodities developed in palm oil industry. This paper presents an application to help in deciding between multiple options of derivative products for all levels starting from upstream, intermediate and downstream level, by scoring them against different criteria. It allows to weigh up all of the factors which are most important to make a decision.

The application in this paper is built in Visual Basic Macro within Microsoft Excel (Macro Excel) by using the decision matrix method. The decision matrix in this application allows to establish the concept of weighting the criteria in order of importance. The resulting scores reflect the importance to the decision maker. The most important criteria, the higher weighting it will be given. So that it will be selected the most valuable for palm oil derivative products automatically by considering all criteria and the whole of the chain of industrial tree.

2. METHODOLOGY

Problem Description

This paper extends previous research from Maryanie et.al (2013) that introduced a framework for determining the most potential commodities developed in palm industry. Determining of derivative industry needs by considering the whole of the chain of industrial tree because almost all parts of the palm have their benefits. However, nowadays most of the producers usually use its FFBs only so that the development of its derivative products is still low. For the example, Indonesia, as the biggest producer of CPO in the world, is not able to surpass Malaysia in the number of its derivative export because Indonesia still focuses on its oil only. Thus, it needs an application to help in deciding the most valuable derivative products of palm so that it can make easier the users to invest their money in order to decrease time and cost.

Model Construction

The approaches of this research are conducted as shown in Figure 1. The model construction used in the application is based on the previous research (Maryanie et.al, 2013). Early stage of this research was started by mapping all product diversifications of palm commodity into palm industry tree. Then making the determination of suitable criteria that can be used to evaluate business competitiveness of each commodity in industrial cluster. The result was obtained seven core criteria named as infrastructure, feasibility analysis, supply, demand, human resource management, technology and law, and environment.

The evaluation criteria that have been established in previous steps are used as a benchmark for commodity performance assessment in every level, starting from upstream, intermediate and downstream levels. This assessment will use an application designed in Visual Basic Macro within Microsoft Excel. Using Macro Excel language makes the user can simply modify the program (Telenius, 1997; Kadjo & Dasgupta, 2013). This macro excel application can analyze business data and present it so that users can make business decisions more easily (Rouse, 2010).

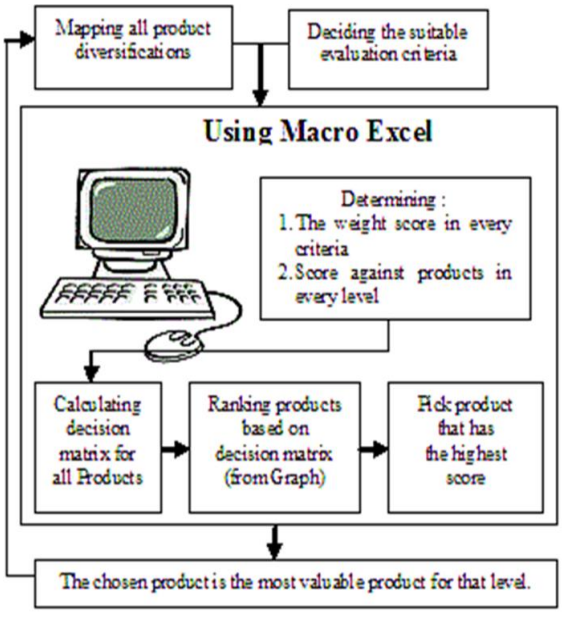


Figure 1: Research methodology of determining the most valuable chain derivative products.

The application proposes to help in creating a weighted decision matrix. The users define weight scores for each evaluation criteria that had been chosen before – seven criteria. The weights will be

given based on their interests to the objectives of the research. Then the user input the scores for each criterion in every level product. This application will help to assess it by creating a weighted decision matrix and macro excel will do the math, rank and pick a winner from all the derivative products. In determining the most valuable chain from all derivative products, the selection process is done in step by step, starting from upstream level to downstream level. If the most valuable derivative product from upstream level has been determined, so the next assessment for intermediate product will be taken from derivative products from the chosen upstream products. And it will be done until the most valuable downstream products have been chosen, so that all the chosen derivative products will form a valuable chain for palm oil industry.

The tree industry of palm oil industry has been investigated by Maryanie et.al. (2013) to capture a map of product diversifications of a commodity and their derivatives schematically. It can be classified into two categories: part of palm oil tree and level of supply chain in the industry. Grouping in part of palm oil tree consist of fresh fruit bunches (FFB), shell as well as empty fruit bunches. While the grouping level of the industry is based on upstream, intermediate and downstream industry. The result of derivative palm oil products is tabulated in Table 1.

Table 1: The result of derivative palm oil products

Levels	FFB	Shell	Empty FB
Upstream	CPO, PKO		
Intermediate	Olein, Soap Stocks, Stearin, Fatty Acid, Carotena, Amino Acid, Fatty Alcohol, Fatty Acid Amines, Trigliserida, Digliserida, Monogliserida, Lipase, Single Cell Protein, Glyserin, Metalic Salt, Fatty Amino, Polythoxiatated Derivates, Ester Dibasic Acid, Cel		Cellulose, Pulp, Lignin, Bunch Ash, Etanol
Downstream	CBS, Shortening, Cooking oil, Soap, Margarine, Salad Oil, Surfaktan, Ice Cream, Vit. A, Methyl ester, Biodiesel, Cosmetics, Fuel, Varnish, Mold Growth Media, Activated Carbon, Animal Feed, Palm Kernel Flour, Food Emulsifier, Confectioneries, Fat Powder	Shell Flour, Activated Carbon, Charcoal, Briquettes, Fuel, Organic Acids, Anty Fungi, Liquid Smoke, Anti Oxidant, Food Preservatives	Animal Feed, Alcohol, Carbon Pellet, Metan, Absorber, Worm Media, Pot Plants, Fertilizer, Biogas, Mold Growth Media, Surfaktan, Compost, Bioetanol, Particle Board, Briquattes, Crates Paper

3. MODEL FORMULATION

The application needs model formulations to perform the decision matrix method in order to select the most valuable derivative products.

Decision Matrix Method

A decision matrix is a tool to decide between multiple options by scoring them against different criteria (Victor, 2011). It is frequently used to describe a multi-criteria decision analysis (MCDA) problem. An MCDA problem, where there are M alternative options and each need to be assessed on N criteria, can be described by the decision matrix which has M rows and N columns, or M x N elements (Figueira *et.al*., 2005). The sum of all scores for each option are compared and ranked, to show the winning.

The application in this paper will be designed using the decision matrix method to select the upstream derivative products. The chosen upstream product will be identified, its derivative products to be selected in the next step as the group of

intermediate products. Different from the selection of upstream products, the group intermediate products will be selected by using a weighted decision matrix method. It operates in the same way as the basic decision matrix, but introduces the concept of weighting the criteria in order of importance. The most important criterion, the higher weighting it should be given.

The weights will be given to each evaluation criteria based on the user's interests to the objectives of the study. Then the user addressed scores to each intermediate product of that criteria. The seven criteria, including infrastructure; feasibility analysis; supply; demand; human resource management; technology; and law and environment were considered in this case study (Maryanie *et.al.*, 2013). The range value of score is 1 to 5, where 1 is low (information N/A- not available) and 5 is high (very valuable). Then, multiply between the assessments with each weights of criteria and total them based on their commodities. The result shows the rank of commodity value of the highest to the lowest.

The chosen intermediate product will be identified, its derivative products to be selected in the next step as the group of downstream products. As the intermediate product selection, selecting of downstream product also uses the weighted decision matrix method. The difference of method between upstream and intermediate-downstream product is because the number products of intermediate and downstream are much bigger than upstream products. It is known that based on the Ministry of Industry of RI (2010), the upstream products of palm commodity are CPO and PKO only.

Building the Model

The model formulation conducted mathematical models to perform decision matrix. In this study, there are m alternatives of derivative products and n decision criteria. Furthermore, assume that all criteria are benefiting criteria, that is, the higher the values are, the better it is. Then, the total performance value of each derivative product is defined as follows in equation (1).

$$P_i = \sum_{j=1}^{n} W_i p_{ij} \quad (1)$$

The following notations are used to develop the proposed equation above.

P_i : Total performance value of the product

W_j : Percentage of the relative weight of importance of the criterion; $\sum W_j = 100\%$

p_{ij} : The performance value of alternative products Pi when it is evaluated in terms of the criterion

i : Derivative product, $i = 1, 2, 3, \ldots$

j : Criterion, $j = 1, 2, 3, \ldots, n$

n : n = 1, 2, 3, …, 7

In assessing the performance values of derivative products P_i when it is evaluated in terms of criterion, this study has its range value. The range value of score is 1 to 5, where 1 is low (information N/A- not available) and 5 is high (very valuable). Table 1 describes the category for performance values. The assessment for each performance value $P_{i,j}$ is based on the Table 2, but the category of performance value for each criterion in each level is different. It is because the assessment of this category is based on data collected. Therefore the determination of the category to assess the performance entirely depends on the data collected.

Table 2: Category for performance values.

p_{ij}	Category of the Assessment
5	High
4	High – Medium
3	Medium
2	Low
1	Not Available or Not Identification

4. RESULT AND ANALYSIS

The application in this paper determines the most valuable chain of palm oil industry, ranging from upstream, intermediate to downstream levels. The application is developed in Visual Basic Macro within Microsoft Excel (Macro Excel). This system is made user-friendly so it can make the selection process easier and more flexible.

Home page of the application is shown in Figure 2. It consists of several menus, such as Product, Input, Output, Home, About App and Exit. To get started, the user has to select one of those menus on the left side of the screen. Product menu will show the palm industry tree that maps all product diversifications of palm commodity and their derivatives schematically. This worksheet explains about a product that will be assessed in this application.

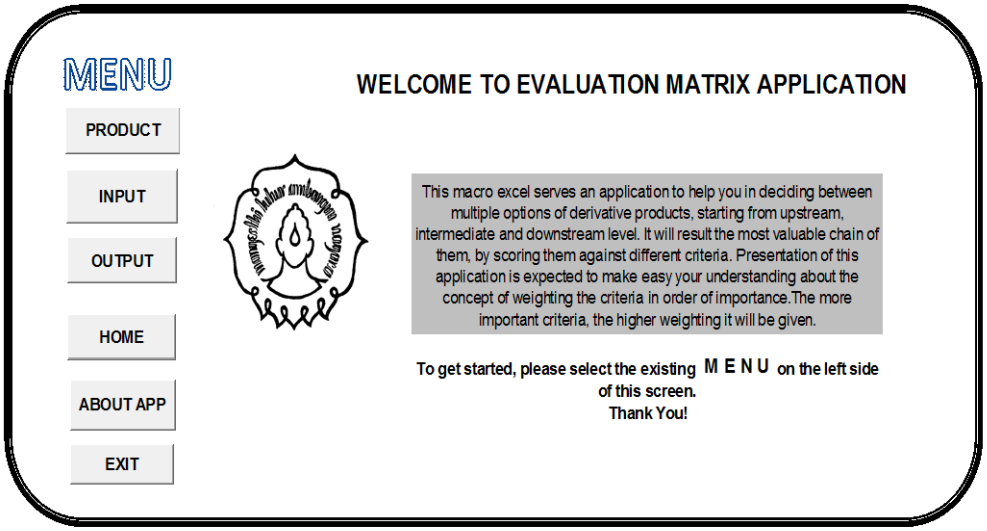


Figure 2: Home page of application.

Input menu will show several empty columns and rows that shown in Figure 3. The user has to input values for weight of each criterion (w_j) and the performance value of the product ($p_{i,j}$). The wig will be given to each evaluation criteria based on the user's interests to the objectives of the study. It shows the concept of weighting the criteria in order of importance. The most important criterion, the higher weighting it should be given. The total of the wig has to be equal to 100 %. Then the $p_{i,j}$ addressed scores to each intermediate product of that criteria. In this study, the range value of score is 1 to 5, where 1 is low (information N/A- not available) and 5 is high (very valuable). The description range of performance values is described in Table 2.

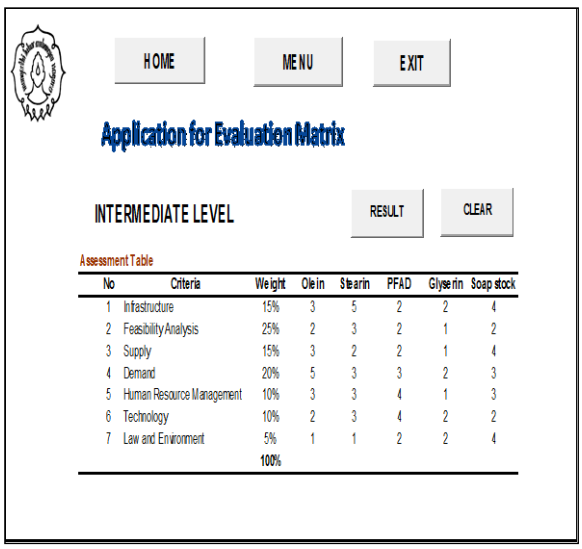
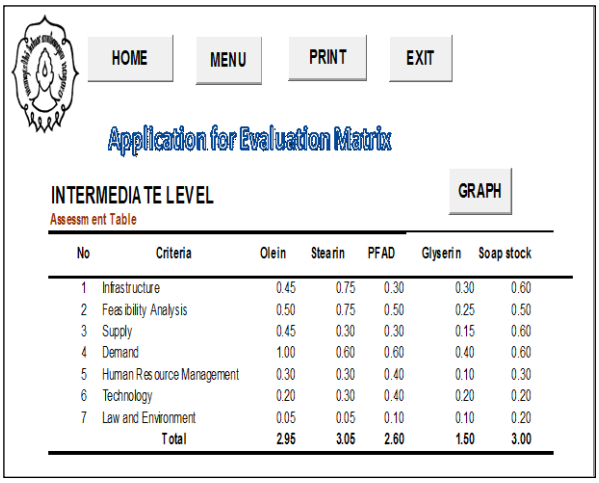


Figure 3: Input menu of the application

After input the assessment for w_j and $p_{i,j}$, then the user has to click a result button. It will lead to Output Menu and show the result, which one is the most valuable derivative product. Fig. 4 shows the result of the assessment, which Stearin is the most valuable derivative product for intermediate level. The final score for Stearin is 3.05. This score will be changed, depends on the scores that the user inputs. Because of that, this application will help users to assess and evaluate product ease and flexibility.

Then, if the user wants to print the final result, he has to click the Graph button on the top of Output menu. It will print the final result out of the paper. And if the user wants to analyze the results more clearly, the application helps it by showing it into the graph form. The user has to click the Graph button on the top of Output menu. The result of this graph is conducted as shown in Fig. 5. However, if the user wants to delete all the assessments before and input score, he has to click Clear Button on the top of Input menu, and all the assessment, final result, and graph will be deleted automatically.

The result of this paper takes data from product of intermediate level. All the assessments use data from case studies in Maryanie *et.al* (2013). The result of the assessment is Stearin as the most valuable derivative product for intermediate level. The final score for Stearin is 3,05. The application can be used for all levels, ranging from upstream, intermediate and intermediate levels. If it uses data from Maryanie *et.al* (2013), the result shows that CPO – Olein – Cooking Oil is the most potential chain of a palm derivative product (Figure 5).



No	Criteria	Olein	Stearin	PFAD	Glyserin	Soap stock
1	Infrastructure	0.45	0.75	0.30	0.30	0.60
2	Feasibility Analysis	0.50	0.75	0.50	0.25	0.50
3	Supply	0.45	0.30	0.30	0.15	0.60
4	Demand	1.00	0.60	0.60	0.40	0.60
5	Human Resource Management	0.30	0.30	0.40	0.10	0.30
6	Technology	0.20	0.30	0.40	0.20	0.20
7	Law and Environment	0.05	0.05	0.10	0.10	0.20
	Total	2.95	3.05	2.60	1.50	3.00

Figure 4: Output menu of the application.

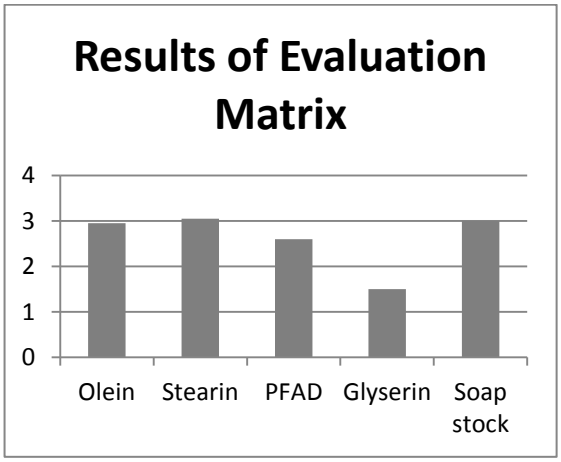


Figure 5: The chart shows final result.

This assessment can be changed at any time depending on the input value. The weight of each criterion is based on the user's interests to the objectives. The most important criterion, the higher weighting it will be given. If weights or scores of commodities change, the calculating of the score will also change automatically. The changes will be done flexibly by choosing one of the weights or scores from listing options. The result comes out in graph form, then ranking of each intermediate products can be seen clearly as the result of priority intermediate products, so that the most potential of intermediate products can be selected. Then, doing these steps again to be used for the selection of all levels, from the upstream to the downstream levels.

Managerial Implication

Pelalawan Technopolis Region, Riau in Indonesia is used to be our case study. Reference Maryanie et.al (2013) showed the importance of the value chain of palm oil industry in the industrial area of Pelalawan Technopoles. The Government will generate the best policy to attract investor invest the derivative palm oil products in the Technopolis Region. This area has strength point that too close to the raw material of downstream palm oil. In other cases, it would be a big problem to determine the most viable commodity to be developed for hundreds of alternatives derivative palm oil products. This application can be used by the regulator (government) to determine which are the most valuable coin from all levels of derivative products in the Palm Oil supply chain. Where, the contents of the part of the palm tree industry and the assessment table criteria can be modified by the user (government) to simulate their policy.

5. CONCLUSION

As a prospective commodity, it is important for the manager to make a right decision in palm oil management. Most viable part of palm oil commodity that will be developed has to be chosen wisely. An assisting tool has been proposed in this paper as a decision support system tool. So that the palm oil management can make the management decision policy more properly.

This paper presents an application to help in deciding between multiple options of derivative products for all levels, starting from upstream, intermediate and downstream level, by scoring them against different criteria. It allows to weigh up all of the factors which are most important to make a decision. The application in this paper is built in Visual Basic Macro within Microsoft Excel (Macro Excel) by using the decision matrix method. The decision matrix in this application allows to establish the concept of weighting the criteria in order of importance. The resulting scores reflect the importance to the decision maker. The most important criteria, the higher weighting it will be given.

The proposed application can be implemented to evaluate which are the most valuable chain from all levels of derivative products. So that the result will help in investing their money in order to decrease time and cost because this application uses seven criteria to determine it. Seven criteria are obtained named as infrastructure, feasibility analysis, supply, demand, human resource management, technology, and law and environment.

The application should be extended by determining the entities or organizations that required to produce the chosen valuable chain before. Supply Chain Operations Reference (SCOR®) model to plan, source, make, deliver, and return analysis might be suitable to overcome this paper's deficiency.

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